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Method of Stabilizing Fluoric Vortex Valves and Vortex Amplifiers

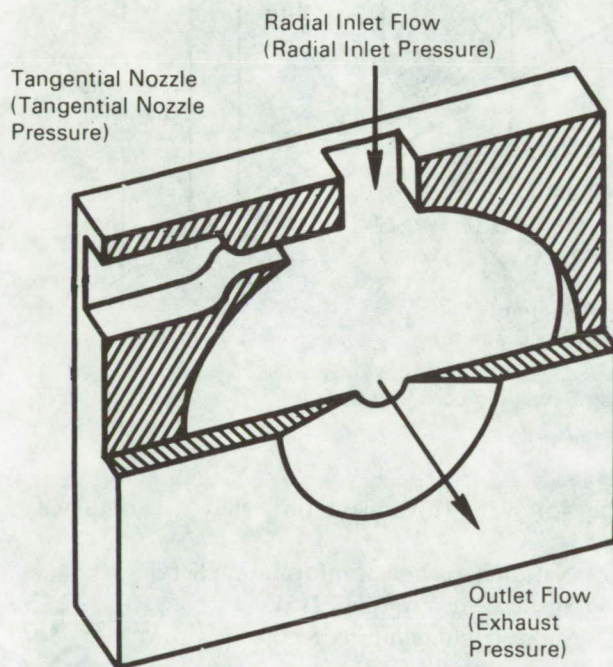


Figure 1. Schematic Illustration of the Vortex Valve

A method of inducing losses in the vortex chamber of vortex valves and vortex amplifiers resolves the problem of unstable operation caused by a sufficiently large positive feedback.

The conventional vortex valve, illustrated in Figure 1, is a short cylindrical chamber with two inlets: a radial inlet and a tangential nozzle. The radial inlet allows fluid to enter the chamber and flow to the outlet orifice without appreciable pressure drop. The tangential nozzle injects fluid tangentially along the cylindrical wall, generating a vortex flow pattern which restricts fluid flow to the outlet orifice.

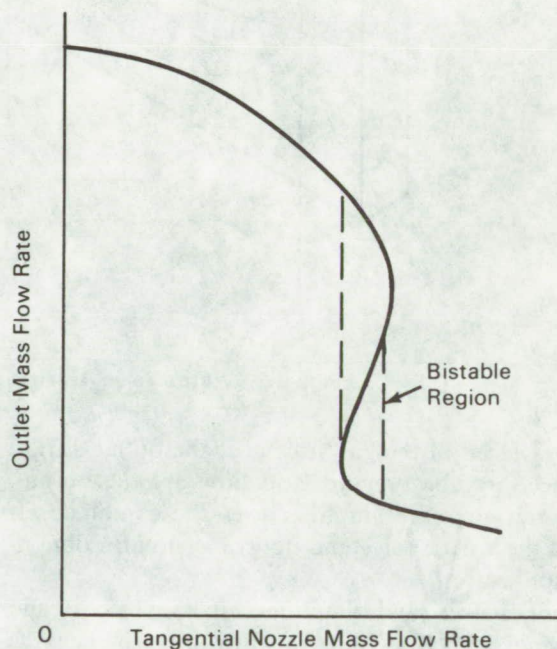


Figure 2. Mass Flow Characteristics of Vortex Valve.

The vortex valve functions as a variable restrictor that modulates flow and amplifies signals in fluid circuits. The total flow leaving the vortex chamber is controlled by the amount of swirl imparted to the fluid inside the chamber. Outlet mass flow characteristics for a constant radial supply pressure are shown in Figure 2. The maximum outlet flow occurs when the tangential nozzle flow is zero — a condition of no swirl in the chamber. The minimum outlet flow occurs when the vortex conditions shut off the radial inlet flow.

A vortex pressure amplifier is similar to a vortex valve with the exception that a receiver tube (pitot

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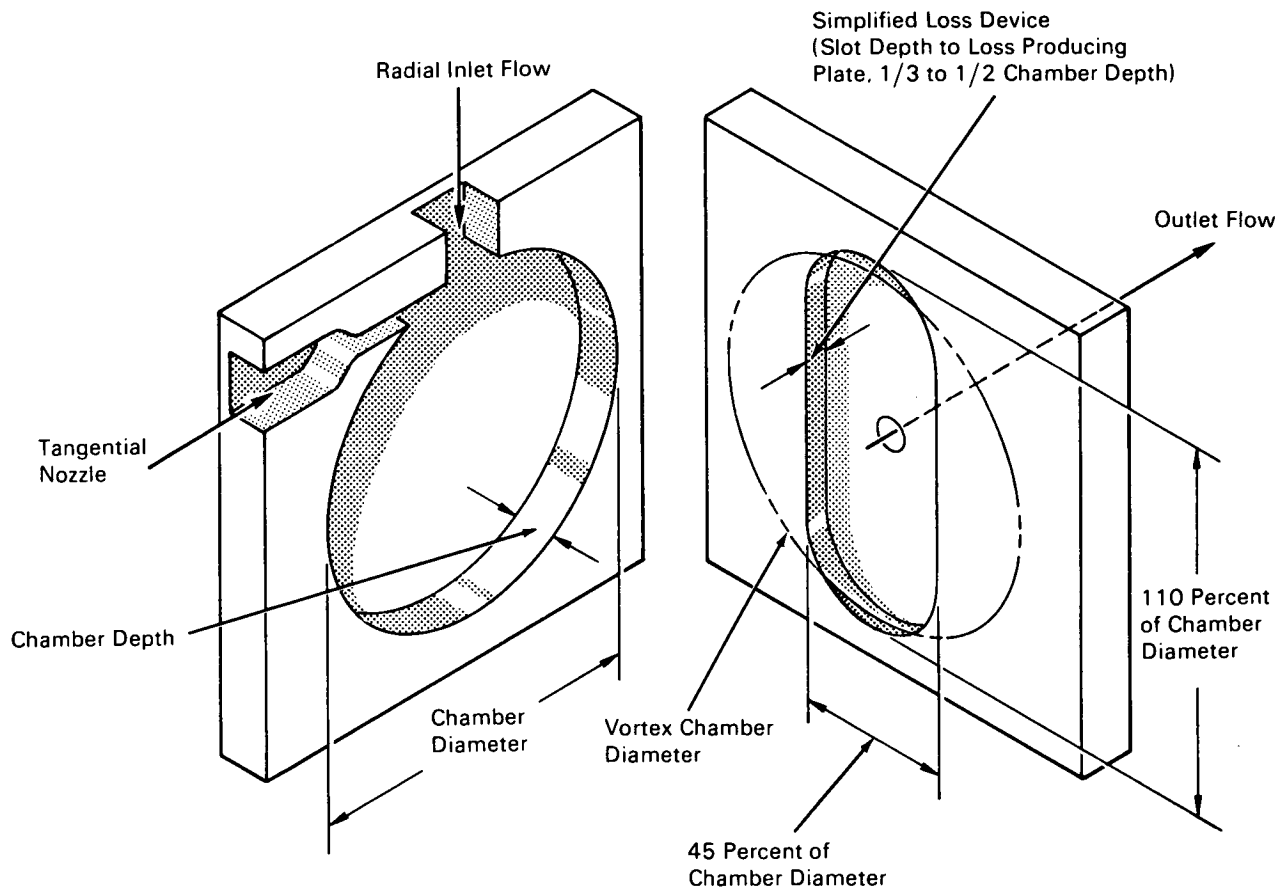


Figure 3. Vortex Valve Assembly Showing Simplified Loss Device

tube) is placed in the gas stream of the outlet orifice. The receiver tube pressure and flow are the output. The vortex pressure amplifier uses the combined effects of the vortex valve and flow diversion for obtaining amplification.

Vortex valves and amplifiers have positive and negative feedbacks within the flow field. When the inherent positive feedback is sufficiently large, the device tends to be unstable and displays the bistable characteristic shown in Figure 2. However, this problem can be resolved by inducing losses (corresponding to negative feedback) in the vortex chamber. These induced losses also reduce both the pressure gain and the throttling range of the device. Grooves in the surface of the end walls of the cylindrical vortex chamber modify the flow and stabilize the device. The effectiveness of this technique varies with the number, size, and location of the grooves relative to the tangential nozzle. An end wall configuration that has eliminated the instability problem is shown in Figure 3.

Note:

The following documentation may be obtained from:

National Technical Information Service
Springfield, Virginia 22151
Single document price \$3.00
(or microfiche \$0.65)

Reference:

NASA-CR-72423 (N68-31116), Fabrication and Test of a Fluoric Position Servo

Patent status:

Title to this invention has been waived under the provisions of the National Aeronautics and Space Act [42 U.S.C. 2457(f)], to the Bendix Corporation, 20800-10 1/2 Mile Road, Southfield, Michigan 48076.

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